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Animal remains from the 4th–5th century AD well at São Miguel de Odrinhas, Sintra, Portugal: tiny sheep and a dwarf dog

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Resumo A escavação dos depósitos de preenchimento de um poço na *villa* romana de São Miguel de Odrinhas, em Sintra, Portugal, datados dos séculos IV/V d.C., revelou mais de 700 ossos identificáveis de mamíferos e de aves. A maior parte dos ossos de vaca, ovelha/cabra e porco correspondem provavelmente a restos de comida. Alguns dos ossos, que de um modo geral se encontram completos, pertencem a um gato, a 7–8 esqueletos de ovelha de pequeno porte, 6 cães, um leitão e um frango juvenil. Um dos cães seria provavelmente um animal de estimação, com pernas arqueadas e altura de ombros de 23–24 cm — entre os mais pequenos espécimes conhecidos no mundo romano. As ovelhas de São Miguel encontram-se entre os exemplares mais pequenos identificados em Portugal, sendo mesmo mais reduzidos do que os de raça Soay, na atual Escócia. A presença destes animais entre os restantes materiais de preenchimento do poço sugere a utilização desta estrutura como local de enterramento ritual de animais de estimação, em determinado momento. Outra explicação possível pode relacionar-se com a simples utilização do local como depósito de lixo doméstico, depois de o poço ter sido desativado da sua função inicial de captação e armazenamento de água.

Abstract Excavation of the contents of a well at the Roman *villa* of São Miguel de Odrinhas near Sintra, Portugal, dated to the 4th/5th century AD uncovered over 700 identifiable animal bones. Many of the cattle, caprines and pigs are probably food refuse. Many complete bones derive from a cat, 7–8 very small sheep, 6 dogs, a suckling pig and a young chicken. One of the dogs was a small dwarfed variety with bandy legs that stood 23–24 cm high at the shoulders — among the smallest known so far from the Roman world. The São Miguel de Odrinhas sheep are among the smallest recorded so far from Portugal being smaller than the Soay, a modern Scottish breed. The pit may have functioned as part of some kind of burial ritual for pets, or simply a refuse hole after its function for obtaining and/or storing water had ceased.

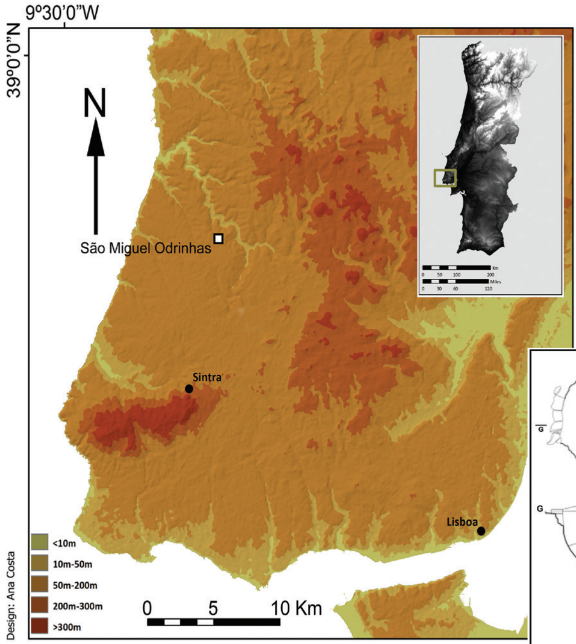
1. Introduction

Animal remains found on archaeological sites generally represent the leftovers of food, or more precisely, meat, eaten in antiquity. Sometimes however, instead of a gastronomic relation, these remains bear witness to a different kind of relation between animal and man — an affectionate or even a religious one. Here we describe animal bones from a well in the Roman villa of São Miguel de Odrinhas which may evidence both food refuse *and* some kind of ritual practise. The villa is almost ten kilometres north of Sintra and five kilometres inland as a crow might fly from the present-day coast of the Lisbon Peninsula; 170 m above sea level at latitude 38° 53' 15" N and longitude 9° 22' 00" W (Fig. 1).

This place has been known since medieval times as São Miguel de Odrinhas (hereinafter SMO). There is evidence of a human presence in SMO in the 1st century B.C., and the *villa* was occupied, apparently continuously, until the beginning of the 5th or even the early 6th century AD, when the main constructions were abandoned. There is also evidence for human presence between the 7th and 10th centuries AD and in medieval times a chapel was built over the Roman ruins (Coelho, 2007, p. 134).

Various parts of SMO were excavated in the course of the 20th century, but in 2004, a well, measuring almost eight metres deep and four metres diameter at the top and one metre diameter at the bottom, was excavated by a team from the nearby museum of the same name under the direction of Alexandre Gonçalves. Nine recognisable levels or stratigraphic units (UEs) which filled the well were recognised. These are UEs 39–54 (Fig. 1 inset, and Gonçalves, 2014). Seven units were recognised from the area above and around the well. Despite the presence of one small fragment of African red slip ware in the form Hayes 15 (Hayes, 1972, p. 41) perhaps from the second half of the 3rd century AD (Bonifay, 2004, p. 158), collected in the sludge accumulated in the bottom of the well, the subsequent deposits revealed a mixture of materials with different dates. These indicate that its filling apparently occurred rapidly over a period of several decades, around the middle of the 4th and the beginning of the 5th century AD and the contents of the levels above and around the well are all contemporary (Gonçalves, 2014, p. 83). The well is filled with building materials that include stones, fragments of tiles, bricks and mortar (*opus signinum*) and *tessellae* (from the mosaic pavements), as well as ceramic fragments (including some pieces of *terra sigillata* and amphorae). Pottery fragments that can provide a fine chronology are scarce and their stratigraphical position within the well does not provide any clear evidence for sequential phases of filling. The deactivation of the well probably occurred at the same time as other structures from the site were abandoned (Coelho, 2007, p. 139) in a process of transformation of the main buildings of the *villa* (Gonçalves, 2014, p. 83). This seems to have happened when many similar rural settlements in the western part of the Roman Empire were abandoned or suffered substantial transformations (Broguiolo & Chavarría, 2008, p. 198).

Included in the well were numerous animal remains. Some of these probably derive from butchery/kitchen waste, but many including several sheep, dogs, pig, a cat and a chicken clearly derive from whole animals. The sheep and probably the pigs too were extremely small and one of the dogs was a dwarf



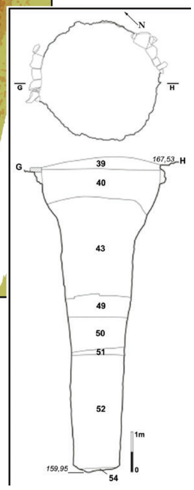


Fig. 1 – Map of the Lisbon peninsula to show the location of São Miguel de Odrinhas; courtesy of Ana Costa. Inset on the bottom right is a vertical section through the well to show the locations of the various stratigraphic units (UEs). These extend down from 167,53 m to 159,95 m above sea level.

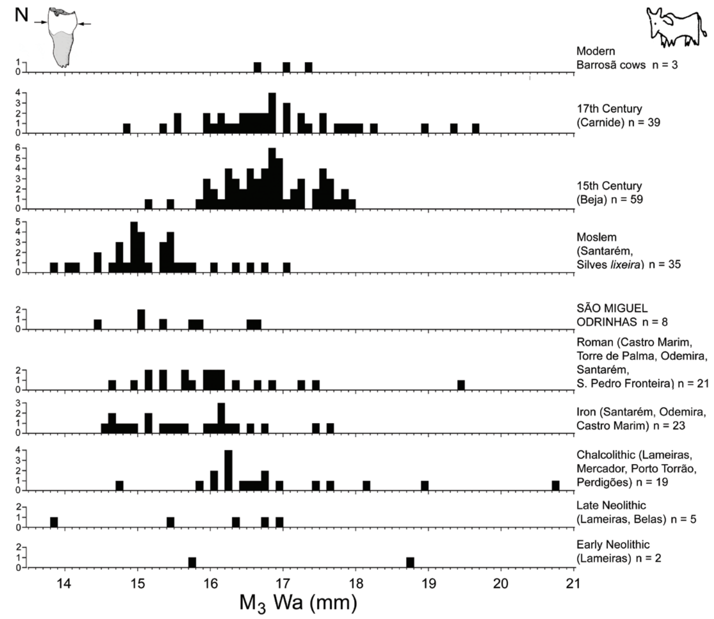


Fig. 2 – Changes in the size of Portuguese cattle from Neolithic to modern times. Stacked histograms of the width of the anterior lobe of the crown of the lower third molar tooth, M_3. "n" refers to sample size. The cattle from São Miguel de Odrinhas are little different from those found in Iron Age, Roman and Moslem Portugal, but smaller than cattle from subsequent Christian times. Artiodactyl molars are not considered to show much sexual dimorphism so that the Moslem *versus* 15th century size increase represents a real size change of cattle in southern Portugal and not a shift in their sex ratio.

with bandy legs. The faunal collection from the SMO well also included an abundance of very small animals. This report describes the fauna found in, around, and on top of the well. The main task is to try and understand what the faunal remains represent. Had the well simply ceased to function and was it then used as a deposit for rubbish or do the contents represent some kind of Roman ritual? Both the excellent state of preservation of the bones and their tight dating to a period no greater than 150 years, as well as the extremely small size of some of the animals, make this an especially interesting faunal collection.

2. Material and methods

The animal bones from SMO were recovered by hand although some sieving was also undertaken. This was more thorough, and a finer mesh was used, for sediments at the bottom of the well, much of which was wet sieved (see below). Most of the bones are well preserved. They include over 700 remains of medium-size and large mammals, a few birds, amphibia and reptiles and a substantial collection of insectivores, rodents and songbirds. The collection of larger mammals is therefore sufficient to indicate approximately the percentages of the more common taxa, and, for the more abundant ones, to provide some useful measurements (in Appendix A) and a rough estimate of their ages when slaughtered (in Appendix B).

The animal remains from the well filling and from the area above and around the well are probably, from a zooarchaeological point of view, distinct as will become apparent.

For a full description of the methods used to record and count the mammal bones see Davis (1992, 2002). Due to the difficulties in identifying many bones of reptiles, songbirds and small mammals, for counting purposes we have concentrated upon the mandibles and humeri of these small animals.

The epiphysis of a mammal-bone is described as either "unfused " or "fused"; "unfused" when there are no spicules of bone connecting epiphysis to shaft so that the two separate easily, and "fused " when it cannot be detached from the metaphysis. Caprine teeth were assigned to the eruption and wear stages of Payne (1973, 1987). Cattle and pig teeth were assigned to the eruption and wear stages of Grant (1982). Measurements taken on the humerus and metapodials are illustrated in Fig. 1 in Davis (1996). Other measurements taken are those recommended by Driesch (1976). Some of these are used to determine the status — wild or domestic — of the animal species in question and others are used to aid in the distinction between taxa as is illustrated in the figures herein. Measurements are also proving to be a useful aid in understanding the variation of animal size in the course of time — variations that can be associated with environmental as well as cultural factors.

The animal remains from São Miguel will be stored in the Archaeology Museum of São Miguel de Odrinhas, near Sintra.

3. Taxa identified (Table 1)

3.1. Cattle

Most of the cattle bones are broken and probably represent the left-overs of meals eaten by the inhabitants of SMO. In terms of their size the cattle appear to be similar to cattle from other Neolithic to Moslem period sites in the southern part of Portugal (see Fig. 2) when cattle were relatively small compared to those, presumably improved, from post-Moslem times. Of the four cattle distal metacarpals, one is small and three are large. Given the degree of sexual size dimorphism of this bone (Davis & *alii*, 2012) it is likely that the smaller one belonged to a cow and the larger ones to bulls/steers. The large *Bos* tibia with a Bd of 62 mm presumably belonged to a bull.

Unlike the first and second lower molar teeth of artiodactyls which each possess two pillars, the lower third molar is characterised by having three. The posterior one is the hypoconulid. Occasionally in cattle; and perhaps in other artiodactyls too, third molars have a reduced or completely absent hypoconulid. This may have something to do with inbreeding (O'Connor, 2000, p. 121; Argant & *alii*, 2013). If found as an isolated tooth; i.e., detached from the mandible ramus, such a tooth could easily be mistaken as an M_1 or M_2. This means that occurrences of this anomaly are probably under-estimated. A specimen from UE 36, although an isolated tooth, was clearly a third molar as there are no signs of the usual interdental abrasion on the posterior surface of the crown which forms a small flange of enamel — a kind of vestigial hypoconulid. Its hypoconulid is thus missing. All the other eight M_3s had hypoconulids present. The first known occurrence in Portugal of a cattle M_3 with missing hypoconulid is from the Early Neolithic at nearby Lameiras (Davis & *alii*, in prep).

3.2. Horse

Several equid bones and teeth were found at SMO. Did they belong to horse, donkey or even mule? A similarity between horse and donkey bones is hardly surprising given their ability to produce, admittedly infertile, offspring.

The shapes of the enamel folds on the occlusal surfaces of teeth, especially the lower molars, can usually enable distinctions to be made between horse and donkey. Similarly, for the bones, certain limb bones can be distinguished via their shape. Horse bones are often, though not always, more robust. Lower molars can be identified by the shape of the enamel folds: the lingual (internal) fold tends to be 'V' shaped in donkey and 'U' shaped in horse and the buccal (external) fold penetrates between the flexids (Eisenmann, 1981). In the upper teeth: the protocone in horses extends backwards while in the donkey the protocone tends to form an oval. An isolated equid lower molar from UE 52 (M_1 or M_2) has an anatomical crown height of 73 mm and therefore belonged to a young adult — the crown is only slightly worn and it has the enamel fold pattern typical of a horse and not a donkey; the internal fold is 'U' shaped and the external one partly penetrates between the flexids. Several upper teeth (both premolars and molars) from UE 43 have protocones that are considerably elongated backwards and therefore probably belonged to horses. However, an equid upper tooth (probably a pre-molar) from UE 18 has an oval protocone and so is more likely to have belonged to a donkey.

In the metacarpal, the sides of the shaft tend to be parallel in the donkey but show a gentle curvature in the horse. An entire metacarpal from UE 43 with its curved shaft sides is more characteristic of the horse. Fig. 3 (adapted from Fig. 7 in Davis & *alii*, 2008) is a plot of shaft width versus relative distal breadth (*i.e.* Bd expressed as a proportion of total length) of proximal phalanges of horse, *Equus hydruntinus*, half ass and ass which shows a reasonable separation of horse from the asses. The SMO proximal phalanx from UE 39 with a shaft width of 32,0 mm and BFd/GL of 41,5/81,6 plots out among the horses.

While most of the equid remains from SMO belonged to horse, and donkey may also have been present, the question of the presence of mule is impossible to verify. Little is known about the osteology of the mule and few Natural History Museums have skeletons of this "artificial" animal.

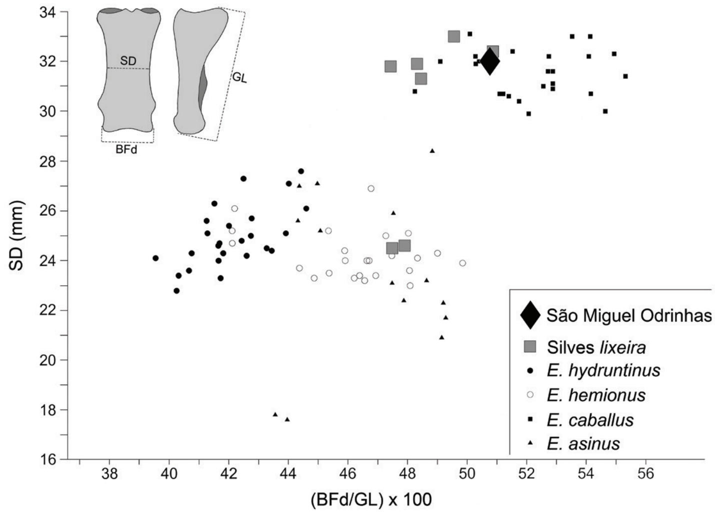


Fig. 3 – Metrical identification of an equid proximal phalanx from São Miguel de Odrinhas. A scatter diagram of the minimum shaft width (SD) plotted against an index: the width measured across the distal articulation (BFd) divided by the greatest length (GL). Note the separation of horse from asses/half asses and the extinct *Equus hydruntinus*. For comparative measurements see appendixes I and II in Davis et al. (2008). Note that with an SD of 32,0 mm and BFd/GL of 41,5/81,6 (= 0,509) the São Miguel specimen clearly belonged to a horse.

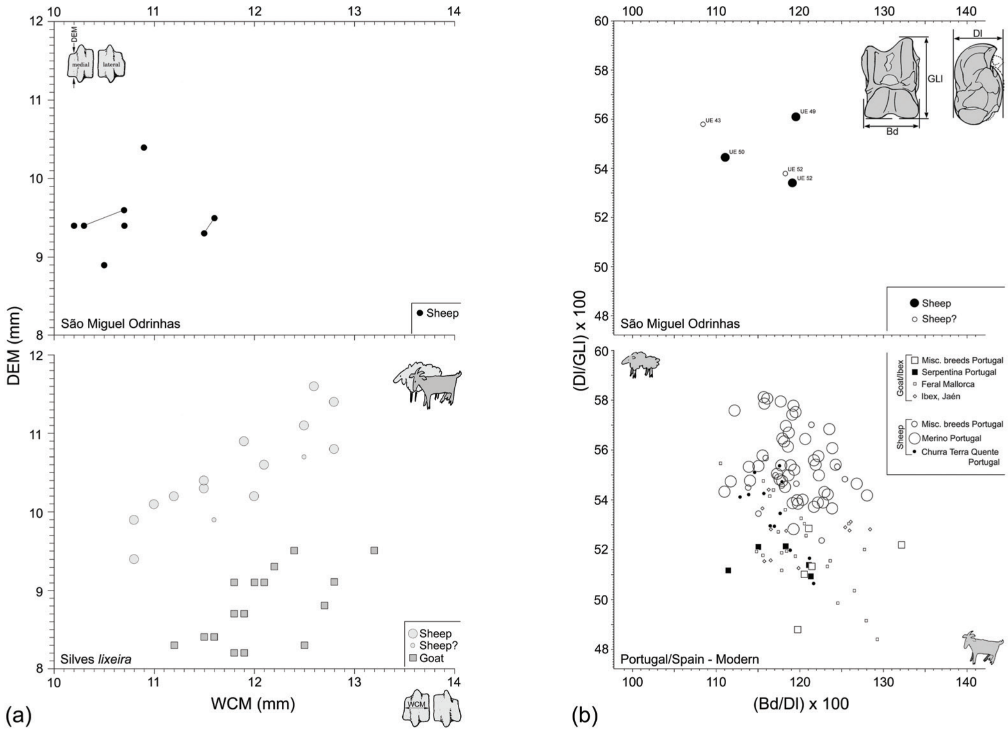


Fig. 4 – Metrical identification of sheep and goat from São Miguel de Odrinhas: distal metacarpals on the left (a) and astragali on the right (b). (a): metacarpal medial trochlea depth, DEM, plotted against the medial condyle width, WCM (after Payne, 1969) of the sheep and goats identified via Boessneck's (1969) morphological criteria from Moslem Silves (Davis & *alii*, 2008) below and the caprine metacarpals all identified via Boessneck (1969) as sheep above from São Miguel de Odrinhas. (b): astragalus distal depth divided by the greatest lateral length, DI/GLI, plotted against the distal width divided by the lateral depth, Bd/DI (after Davis, in press). Below, modern sheep and goat astragali from Portugal and Spain indicate partial separation of modern sheep from goat.

3.3. Caprines (sheep and goat)

Sheep and goat bones are easily confused. For most parts of their skeleton it is difficult or impossible to identify them as definite sheep or definite goat. However some can be identified. Small morphological differences on bones like the distal part of the humerus, distal metapodials, calcanea, astragali and terminal phalanges described by Boessneck & *alii* (1964) and Boessneck (1969) indicate that the majority of the caprines at SMO belonged to sheep with just some goats present. Measurements taken on two bones — the distal metacarpal and the astragalus — can be used to separate sheep from goat (Payne, 1969 for the metacarpal; Davis, in press for the astragalus) although often the separation is incomplete and so these metrical methods should be used merely as an aid to corroborate the morphological identifications. Fig. 4a shows the metacarpals from SMO — all of which are identified morphologically as sheep and most seem to be metrically sheep too. Note they are all small when compared with sheep from Moslem Silves (Davis & *alii*, 2008). Clearly all the caprine metacarpals at SMO are both morphologically and metrically sheep. All specimens are from adult animals, *i.e.* with epiphyses fused to their respective shafts. Two pairs — each a left and a right metacarpal — almost certainly belonged to the same animal and are joined by a line. The astragali, identified morphologically as sheep, are also sheep-like in terms of their shape (Fig. 4b; see Davis, in press). The 5 astragali from São Miguel de Odrinhas all identified via Boessneck's (1969) morphological criteria as sheep, seem also to be metrically sheep-like.

To demonstrate just how small the SMO sheep were, Fig. 5 shows five SMO complete sheep metacarpals alongside a modern male and female merino sheep and a modern female Soay sheep. Today merinos are among the

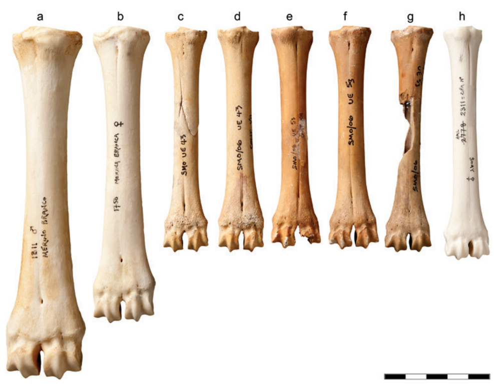


Fig. 5 – Five complete sheep metacarpals from São Miguel de Odrinhas (c - g) alongside those of three modern sheep to show just how small were the SMO sheep. Key: a and b – male and female Merino, one of the largest breeds; h - female Soay, one of the smallest breeds. Note that metacarpals c and d are probably from the same animal as are also e and f (see Fig. 4 left graph).

largest sheep while the Soay is one of the smallest breeds. The SMO sheep were therefore extremely small and as Fig. 6 shows, are clearly some of the smallest recorded so far in Portugal. Only the small sample of Iron Age sheep from Castro Marim and Alcáçova de Santarém were this small.

3.4. Pig

Pig bones and teeth tend to be smaller than those of wild boar but for many measurements there is overlap impeding any certain separation between wild and domestic (Payne & Bull, 1988). This distinction is even more difficult to make in the Iberian Peninsula where the wild boars are rather small. In our study (Albarella & *alii*, 2005) of *Sus* from Holocene Portugal we found that at many sites, especially Chalcolithic Zambujal, most measurements of *Sus* bones and teeth formed a cluster while there were a few somewhat larger-sized specimens. Like Driesch & Boessneck (1976) in their original study of the Zambujal bones, we also interpreted the small ones as having belonged to domesticated *Sus* (i.e., pig) and the few large specimens as wild boar. By applying this logic and assuming our interpretation was correct the few measurements that we have for the SMO *Sus* teeth and bone are too small to have belonged to wild boar. The SMO *Sus* remains all belonged to pigs. The majority of the teeth and bones of *Sus* belonged to young animals. Indeed many of the *Sus* bones in UE 52 and UE 53 were from foetal or new-born animals and so few measurements could be taken of adult remains. Three lower first molars, four lower second molars and two lower third molars are very small indeed and all came from within the well. Their measurements plot out among the smallest of the presumed domestic pigs from Chalcolithic Zambujal and Leceia and some are even considerably smaller still (compare their measurements with those shown in the various tooth measurements given in Albarella & *alii*, 2005). The only adult *Sus* bone that could be measured is a distal tibia and it came from UE 33, outside the well. With a Bd of 28,5 mm it seems to be of medium size and plots in the middle of the pig tibiae from Zambujal and Leceia that are presumed to have been domestic. Perhaps like the small sheep and dogs, also found within the well, these small pig teeth, belonged to some kind of extremely small (even dwarf) animal although with so few measurable teeth and bones it is not possible to say much more.

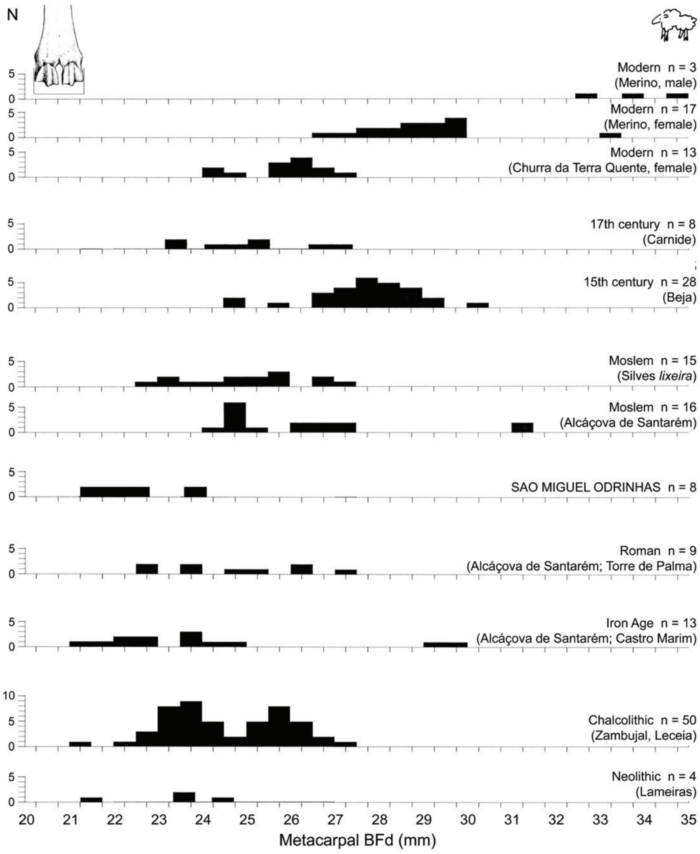


Fig. 6 – Chronological changes in size of Portuguese sheep. Stacked histograms of measurements of the distal width (BFd) of metacarpals adapted from figure 7 in Davis (2008). "n" refers to sample size. Note the very small size of the sheep from São Miguel de Odrinhas. They were probably on average the smallest sheep known from Portugal.

3.5. Black rat

A black rat humerus was found in UE 53 and a mandible in UE 52 — i.e., at or near the bottom of the well. The mandible is clearly black rat with a tooth row length (measured across the M_1 to M_3 alveoli) of 6,4 mm. In comparison three modern *Rattus norvegicus* in our reference collection measure 7,6, 7,3 and 7,5 mm (from the Beira litoral of Portugal, Portuguese Estremadura and Asturias in Spain respectively) while three modern *R. rattus* measure 6,9, 6,5 and 6,7 mm (from Cyprus, Beira Alta in Portugal and Berlenga island Portugal respectively). The black rat serves as a reservoir for bubonic plague which is transmitted from rat to man by the flea *Xenopsylla cheopis*. Black rats are thought to have come from India having been accidentally introduced by ship — hence its other name 'ship rat' — and are known from Hyksos times in Egypt (1750–1550 BC; Boessneck, 1976), and the '*ofalim*' in I Samuel 5 and 6 that afflicted the Philistines in Ashdod could have been plague. Black rats must have come to Italy before AD 79 as they are known from Pompei, soon after in Switzerland, southern Germany and they are widely reported from Roman sites in England (Rackham, 1979; Armitage & *alii*, 1984).

Fig. 7 – Dog humeri from São Miguel de Odrinhas. The dwarf dog "e" with a length, GLC, of 79,8 mm and other small dog humeri from SMO. All were found in UE 43. For comparison a modern male livestock guard dog, the Castro Laboreiro (LARC reference collection #1162), is shown on the left "a" and on the right, "f", a modern Portuguese fox humerus (LARC reference collection # 210). Humeri "b", "c" and "d" are small - medium sized dogs from SMO and have GLC values 146,1; 140,4 and 122,3 mm respectively.

Fig. 8 – Dog ulnae from São Miguel de Odrinhas. The dwarf dog from São Miguel de Odrinhas, "d" (length = 79,8 mm) from UE 43. This is shown alongside, from left to right, the ulna of a modern male livestock guard dog, "a", the Castro Laboreiro (LARC reference collection #1162), two proximal fragments of small-medium sized dogs from São Miguel de Odrinhas, "b" and "c"; and on the right, "e", a modern Portuguese fox ulna (LARC reference collection # 210). Inset on the bottom right hand side is a distorted dog tibia from UE 43. Did the owner suffer a break earlier in its life? If this was the case, the complete healing of the fracture indicates the animal may have been well cared for by its owners.

3.6. Dog

The dog and its ancestor, the wolf, both belong to the genus *Canis* and are morphologically difficult to distinguish. Their bones and teeth are generally separable on the basis of size with dogs being somewhat smaller. There is however some overlap between large dogs and small wolves. The lower carnassial tooth (M_1) is usually easier to separate and M_1s with an antero-posterior crown length less than 24 mm are almost certainly dogs. At least six dog skeletons were recovered from the well. All were found in UE 43. Their lower carnassial tooth crowns range in length from 15,6 to 22,0 mm — too small to belong to wolves.

The SMO dog teeth and limb-bones indicate that most belonged to medium sized animals. But one skeleton is exceedingly small. A complete ulna and humerus, both of which probably belonged to this same small dog are shown in Figs. 7, 8 and 9. When viewed (Fig. 9) alongside limb-bones of several modern breeds of small dog from the archaeozoology reference collection of the Universidad Autónoma, Madrid, such as Chihuahua, dachshund (teckel), Yorkshire terrier, Pekingese and Lhasa apso, the small SMO dog clearly belonged to a similarly small animal. Harcourt (1974) devised indexes for calculating the shoulder height of dogs from limb-bone lengths. These are: [(3,43 x humerus length) – 26,54]; [(3,18 x radius length) + 19,51] and [(2,78 x ulna length) + 6,21]. The three complete limb-bones, a humerus, radius and ulna from SMO have lengths of 75,3; 67,7 and 79,8 mm respectively. Harcourt's indexes thus indicate that this small SMO dog stood some 23 — 24 cm high at the shoulders — smaller than any that Harcourt found in Roman Britain (for example the range he found for Roman British ulnae range from 87 to 235 mm while that from SMO is a mere 79,8 mm). It seems the small SMO dog had bandied limbs considerably shorter than those of a fox and somewhat reminiscent of a modern dachshund.

The Romans and even their Iron Age predecessors are well known for possessing very small breeds — a sign, perhaps, of luxurious living (Harcourt, 1974; Baxter, 2010; Bennett & *alii*, 2016; Bennett & Timm, 2016) and the ancient Greeks and Romans were among the earliest peoples known to keep pet animals. The Romans had hunting, guard and shepherd dogs, draught and performing dogs and pet dogs and their iconography depicts various 'types' of dog including hunting dogs and pets such as small toy dogs (MacKinnon, 2010).

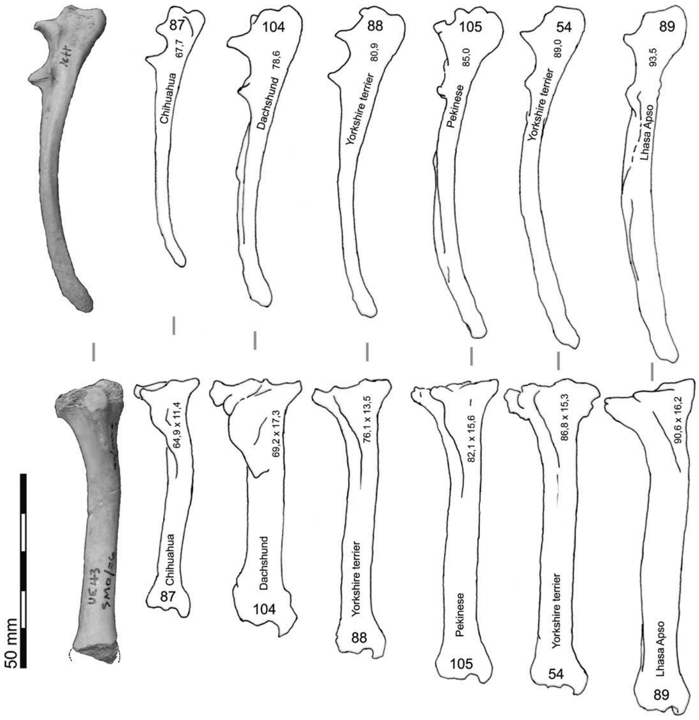


Fig. 9 – Dog ulnae and tibiae. The dwarf dog from São Miguel de Odrinhas (UE: 43). Photographs of the complete ulna (length 79,8 mm) and a tibia whose distal end is missing alongside outline drawings of ulnae and tibiae of six small breeds of modern dogs in the reference collection of the archaeozoology laboratory, Universidad Autónoma, Madrid. The UAM catalogue numbers are shown at the top of each ulna and bottom of each tibia. The measurements, in millimetres, are also given – for the ulna the length, and for the tibia the length x the distal width. The dogs are from left to right: Chihuahua ♀, dachshund ♀, Yorkshire terrier ♀, Pekinese ♂, Yorkshire terrier, Lhasa Apso ♂. The toy dog from SMO was probably similar in size, and perhaps shape, to one or several of these small modern breeds.

In Roman Germany authors have described the wide variety of dog 'types'. They include some as small as 25 cm at the shoulder — still not quite as small as the SMO specimen (see for example Berke, 2003; Küchelman, 2013). Baxter (2010) describes the morphology of very small Roman dogs and points out that "smallness" can be of two main kinds. One type includes 'midget' or 'toy' dogs that have scaled down limb bones. They can be extremely small but normally proportioned like the miniature poodle, Chihuahua, miniature doberman and the Maltese (Deb Bennett, pers. comm.). The other type includes 'dwarf' dogs with their bandy legs. These apparently suffer from an endochondral ossification disorder known as achondroplasty - that results in disproportionately short limbs with heavy curving of the shafts of the limb-bones — as in the corgi, basset hound and the dachshund today. Baxter's (2010) descriptions of 'dwarfed' dogs seem to match our very small dog from SMO.

Perhaps the smallest Roman dog skeleton is that found at Yasmina, Carthage, whose withers height was of the order of 20–21 cm. Another from Heidelberg, Neunheim in Germany was 21–22 cm. But both of these were 'midget' or 'toy' dogs. They were probably high-status pets and were buried with children (MacKinnon & Belanger, 2006; Baxter, 2010). Baxter also gives withers height measurements of another small Roman dog from Love's Farm in Cambridgeshire, England which was 21 cm high and was a 'dwarf'. Clearly our small dog from SMO was not alone in the Roman world!

Unfortunately most of the SMO canid crania are crushed and so it is not possible to determine what the face and head of this small dog might have looked like. However the smallest dog mandibles are fairly complete with just the anterior part with the incisor teeth missing. There is nothing untoward about these mandibles although the P_1 was missing from the left mandible and there is no trace of the P_1 alveolus. The right mandible still has a normal alveolus for this tooth although the tooth itself is missing. And neither mandible shows any especial sign of disproportionately sized teeth or dental overcrowding/overlapping.

A tibia of an adult dog from UE 43 has a bent shaft (Fig. 8 inset). This probably broke in early life and subsequently healed – evidence perhaps that it was well tended.

3.7. Cat

Numerous bones including two mandibles, and most of the long-bones (i.e., both from right and left sides) of a cat were found in UE 52. Another two bones, a third phalanx and a calcaneum, found in UE 53 could have fallen down during excavation. With its lower carnassial tooth measuring 8,2 x 3,5 mm its size is similar to carnassials of modern cats from Europe and the Maghreb (see figure 35 in Davis, 2002). Given the state of epiphysial fusion of the different bones in its skeleton it was probably aged between 10 and 14 months (see below).

3.8. Other medium-sized taxa

Other taxa found in small quantities include red deer (a few tooth and limb-bone fragments); a single humerus of rabbit, and a fragment of an ischium that probably belonged to a roe deer. A femur of an adult mustelid, a stoat or weasel, was also identified.

3.9. Birds

Several medium-sized bird bones identified include starling, turdidae (thrushes), magpie, stilt and eagle owl. Whether these birds were hunted for food or merely fell into the well cannot be ascertained. Several small songbird bones were also found in these same UEs but most could not be identified to genus or species. However a number of characteristically short stout humeri almost certainly belonged to swallow (*Hirundo rustica*) and a complete tarsometatarsus (length = 10,2 mm) belonged to the swallow family. A number of probable greenfinch (*Carduelis chloris*) bones were also identified. These small birds probably form part of the assemblage contained in owl pellets described below.

The faunal remains from SMO include bones of galliformes. This group of economically important birds includes the closely related *Gallus, Numida* and *Phasianus* (*i.e.* chicken, guinea fowl and pheasant). Most bones of these three taxa are difficult to identify to species (see for example MacDonald, 1992). The chicken is descended from the red jungle fowl (*Gallus gallus*) of east and south-east Asia, where it was probably domesticated several thousand years before Christ (Zeuner, 1963, p. 444; Benecke, 1993). It was gradually brought across to the Mediterranean and Europe via the Middle East. Its spread across the Mediterranean is associated with the Phoenicians. According to Hernández (1992), the earliest evidence for chicken in Iberia is during the first part of the Iron Age when its remains appear only in Phoenician sites or sites with Phoenician influence. It is interesting that the chicken 'suddenly' appears in phase V of Castro Marim (Iron Age: second half 5th century–3rd century BC; Davis, 2007). The Romans however were well acquainted with the other two birds — guinea fowl (*Numida*) and pheasant (*Phasianus*). Guinea fowl, a North African bird, which Varro refers to as '*Gallinae Africanae*' (Hooper, 1935; 480) was brought to Europe by the Romans (Mongin & Plouzeau, 1984) and the Roman cookery writer, Apicius, mentions *pullum numidicum*. The pheasant was also introduced into Europe from N.E. Asia Minor/Georgia by the Romans (Blank, 1984). Using both the LARC reference collection that includes bones of the various galliforme taxa and Tomek and Bocheński's (2009) guide to identifying galliform bones, we are able to suggest that most, perhaps all the galliform bones belonged to *Gallus* (chicken) rather than pheasant or guinea fowl. To give some examples: two incompletely ossified (i.e., juvenile) femora from UE 52 and probably from the same animal have no foramen in the proximal part of their shaft. This rules out pheasant but does leave both *Gallus* and *Numida* as possibilities. However they seem too small to have belonged to *Numida*. A carpometacarpus from UE 53 has a well developed '*processus intermetacarpalis*'. This process, present in both *Gallus* and *Phasianus*, is absent from *Numida*. A distal tarsometatarsus from UE 38 has no posterior keel running down the shaft which rules out its having belonged to *Phasianus*. Due to the somewhat narrow and long rather than wide and short shape of the epicondyle of the trochlea of the second metatarsal, this bone probably belonged to *Gallus*.

3.10. Very small mammals

Many small animals were also identified. Most were found in the lower parts of the well especially in UEs 52, 53 and 54. They include amphibia (*Bufo bufo*), lizard (*Lacerta* cf *lepida*), greater white-toothed shrew (*Crocidura russula*), dormouse (*Eliomys quercinus*) voles (*Microtus* cf *lusitanicus* and *Arvicola sapidus*) and mice (*Apodemus* sp. and *Mus* sp.) as well as an abundance of small song birds including *Hirundo rustica, Carduelis chloris* and many unidentified passeriformes.

Closer observation of <u>some</u> of the small animal bones under a low power microscope revealed that their surfaces had been abraded in a manner similar to the surface etching obtained when leaving bone in acid or stomach juices. This surface degradation occurs on bones of small animals consumed by owls and subsequently regurgitated as pellets. Given this surface damage and the clustering of most of the small animals in the bottom of the well, one could suggest that they derived from owl pellets regurgitated by owls roosting at the edge of the well before it became filled. Furthermore it is also possible that the well was situated in some kind of barn perhaps exposed to the outside and owls roosted in the roof of such a structure and either dropped their pellets directly into the well or onto the ground where they were subsequently swept or blown into the empty well.

4. The age at death of the animals (Table 1 and appendix B)

Most of the pigs are juvenile which is not surprising as this animal is generally only reared for its slaughter products like meat and fat, indeed nearly all the pig remains *in* the well (in UEs 52 and 53) belonged to new born/foetal piglets and the three pig bones that belonged to adults were found above the well. The pig teeth tell a slightly different story. While most of the pig teeth within the well belonged to juveniles, there were also two adults present. A young adult sow (M_3 in wear stage 'a') was found in UE 50 and a very old sow (M_3 in wear stage 'g') was found in UE 43. These could be sexed via the shape and size of their canine tooth or canine alveolus. Most of the dog bones belonged to young adults with little or no dentine exposed on the crowns of their teeth. Bones, probably of a single individual juvenile dog, are all with unfused epiphyses (scapula-coracoid, distal humerus, distal radius, distal femur, distal tibia, calcaneum-*tuber calcis*, distal metapodials and proximal phalanges) and must have belonged to a puppy a few months old. Most of the cattle and all but one of the equid remains were adults — presumably retired work/milking animals that were slaughtered for consumption at the end of their useful life. The more common limb bones of the caprines (mainly sheep) indicate that perhaps one half were osteologically immature at death. A consideration of the state of epiphysial fusion of the various limb bones of the cat indicates that it was a young adult. Thus while certain bones were fully fused (scapula-coracoid, distal humerus), others, while fused, still had clearly visible suture lines (distal tibia, some distal metapodials) and others were still unfused (distal radius, femur, proximal tibia and calcaneum-*tuber calcis*). If we assume that all these bones derived from the same cat and given its state of limb-bone development, it was probably aged around 10–14 months (see Smith, 1960 for the ages when these epiphyses fuse in the cat).

5. The bones — isolated or from complete animals; chopped or entire?

In general animal bones found in archaeological sites derive from the food remains of our ancestors — slaughterhouse, butchery and kitchen refuse. It is seldom possible to match, say, a left humerus with its respective right humerus. Bones are also nearly always broken — chopped during joint preparation and broken for marrow extraction. Disjointing and defleshing often leave cut marks. However, here at SMO, chop and cut marks, as well as signs of pathology and gnawing are scarce. There is only a single bone — a sheep metacarpal from UE 54 — which shows signs of a chop. Only three bones have cut marks — two cattle proximal phalanges in UEs 39 and 52 and a caprine pelvis in UE 43 with a *probable* cut mark. Many of the bones — in particular of sheep, pigs, cat and dog were not only complete and unbroken but it was possible to match left bones with their respective right ones. Many entire skulls were also found, as were many sheep and probable dog ribs and vertebrae that show little sign of breakage. This scarcity of butchery marks on the bones and indeed the fact that many/most of the small sheep, pig, cat and dog bones and various skulls were entire, indicates that rather than food refuse we have a deposition of whole animal carcasses, as well as some food waste. Three bones show signs of gnawing, presumably by dogs. They are an equid astragalus from UE 29, a caprine calcaneum from UE 43 and a cattle calcaneum from UE 33. It may also be of some relevance that two metapodials found in UE 53 with old breaks (i.e., clearly not made during the archaeological excavation), one a distal sheep metatarsal (the two condyles plus parts of their respective shafts) and the other, a proximal and a distal half of a sheep metacarpal, could be joined. In both cases the joining 'halves' had slightly different colours indicating that perhaps they were deposited in slightly different parts of the stratigraphic unit — i.e., they were broken prior to burial.

6. The location of the various animals (Tables 2 and 3)

Archaeological animal bones are usually haphazardly scattered. Here at SMO, if we look at the distribution of the different size-groups of animals and different species some interesting patterns emerge. Almost all the microfauna and wild birds (lizards, amphibia, song birds, and birds such as eagle owl and stilt, rodents and shrews) were recovered from the bottom of the well in UEs 51 to 54. This imbalance between the bottom and middle/top of the well is made very clear when we express as a percentage the proportion of microfauna in relation to both micro + macro fauna (Table 3). In these units at the bottom of the well, the percentages of microfauna are 22, 15, 58 and 88 respectively. The only other UE in the well with some microfauna is UE 39, but with a mere 9%. The apparent concentration of microfauna in the bottom of the well may to some extent be real but we cannot rule out the possibility that it reflects the differential recovery of fine materials in the lowest levels. The sieve used in the bottom of the well had a mesh size of c. 5 mm while that used in the other deposits was slightly larger with a mesh size between 5 and 10 mm. Moreover due to the wet conditions in the bottom of the well, parts of the sediments there were sieved with water.

While bones of large and medium sized taxa like cattle, equid, sheep, goat, pig and chicken were present throughout the sequence from levels above, around and within the well, their distribution is interesting. Questions we need to ask are: were whole animal carcasses buried in the well and for each taxon buried, what proportion was juvenile or even neonatal? Since most of the bones recovered were received for study completely separated and in various different bags, it is not an easy task to attempt to reconstruct whole skeletons. However, if long bones for example are preserved complete, *viz*., unbutchered, it seems more likely that they came from entire skeletons. The taxa that are most clearly represented by complete long bones are cat, dog and sheep and probably pig and chicken too.

There are several entire bones of adult cattle and equids. Five, a metacarpal and a radius of cattle and a metacarpal, metatarsal and humerus of equid, were found within the well and three, a metacarpal and metatarsal of cattle and a metatarsal of equid, were found above the well. But with these being the only entire long-bones represented of these two large animals, it seems probable that they derive from the burial of isolated limb-bones and not whole cattle and equid carcasses as was clearly the case for the cat, dogs, sheep and probably the pig and chicken. Almost all the red deer remains were located in the layers above the well (UE 29, 33 and 34) with only one bone in UE 40. And most of the equid remains came from within the well.

The pig remains in the well belonged to both adults and juveniles as mentioned above. All the pig bones and teeth, probably belonging to a single animal, in UE 52/53 belonged to a neonatal/foetal animal, presumably suckling pig, and the heads of two adult sows, one young adult and one very old individual, were buried higher up in the well in UEs 50 and 43 respectively.

Many of the sheep bones are fragmented. They were found both above the well and within it and are presumed leftovers of meals. The distribution of the entire long-bones of sheep, however, parallels quite closely that of the dogs and cat. They all come from UEs 43 and 53 within the well and it was possible to match left with right sides of some of these entire sheep bones. They probably belonged to some seven or eight sheep. Three or four of these are from adults or young adults and perhaps four are juveniles. Of the juveniles, it is likely that there were two in UE 43 and two in UE 52/53.

Most of the cat bones are entire and there is little doubt that a single cat — a young adult — was buried in UEs 52 and 53. Most of the dog bones too, all found in UE 43, are entire. They probably belonged to six animals. Five were adults or subadults and one a puppy (see above for a discussion of its age-at-death).

In UEs 52 and 53 the finds of several incompletely ossified (i.e., juvenile) chicken bones (two femora and two humeri) suggest that a young chicken was also deposited in the bottom of the well.

We speculate that the well served as a grave or burial hole for the small pigs, small sheep, dogs, cat and chicken.

7. Discussion

It is unusual to find within an archaeological site a small toy dog with bandy legs, a young-adult cat and complete carcasses of exceedingly small sheep and pigs. When whole carcasses are found they are generally thought to signify a special status of the animal in question. Do we have here in São Miguel de Odrinhas evidence for some kind of special relation with these small sheep, pigs, dogs and cat? The absence of cut and butchery on the bones of the dogs, cat and most of the small sheep and the completeness of their bones as well as their probable, indeed almost certain, original existence as whole carcasses could signify that they had some kind of affectionate rather than gastronomic relation with their human owners and that they were buried in the well — perhaps a place of some special or even ritual significance. The fact that the sheep, cat and dogs were not particularly old individuals may also indicate that they were sacrificed to appease the Roman gods. Indeed, that the cat and probably all except one of the dogs were young adults is very striking. Their bones, apart from the bent dog tibia, show no signs of disease or senility. Their death must have been brought about artificially and they were not slaughtered for the table. A more mundane explanation is that these animals died of natural causes or disease and were simply disposed of by being jettisoned into the disused well.

We can suggest a 'history' of the well and its contents. It was originally excavated prior to the 4th/5th century AD for obtaining and/or storing water. During or soon afterwards, perhaps when it had become defunct, owls roosting in the building above or even at the edge of the well deposited their pellets containing the skeletons of shrews and rodents. This would account for the presence of rodent, insectivore and song bird bones in the bottom of the well. At the same time the bottom of the well continued to be damp and harboured the amphibians, some of which eventually died there. Then in the 4th/5th century the well began to function either as a place for the ritual burial of dogs, a cat, several small sheep and a suckling pig — perhaps all with some kind of special relation with the local people. Earth containing household debris that included kitchen waste (i.e., food waste in the form of animal bones) was also included with the buried animals.

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Bone/tooth	F/U	*Bos*	O	(*Ovis*)	(*Capra*)	*Sus*	CEE	EQ	ORC	CAC	*Canis*	*Felis*	Galliform	OTHER
dP_4		2	10	(8)	(-)	3	-	-	-	-	-	-		
P_4		3	11			4	1	-	-	-	6	-		
M_1		2	17			7	1	-	-	-	12	2		
$M_{1/2}$		11	36			-	-	1	-	-	-			
M_2		4	14			5	-	-	-	-	4			
M_3		11	23			4	-	-	-	-	-			
							-	-	-					
Scapula	U	-	3			3	-	-	-	-	2	-		
"	F	2	4			1	-	-	-	-	9	2	1	
"	?	4	3			1	-	-	-	-	2	-		
Humerus	UM	-	2			1	-	-	-	-	2	-	2 juvenile	
"	UE	-	4			-	-	-	-	-	1	-		
"	F	3	6	(4)	(2)	-	-	1	1	-	11	2		1 HIH; 1 *Pica*; 2 ST; 1 TUR
Radius	UM	-	7			1	-	-	-	-	-	2		
"	UE	-	2			-	-	-	-	-	2	-		
"	F	2	1			-	-	-	-	-	7	-		
Metacarpal	UM	½	6	(1)	(1)	1½	-	-	-	-	-	-		
"	UE	½	-			-	-	-	-	-	-	-		
"	F	3½	8	(8)		-	1	1	-	-	-	-	2 CmC	
Ischium		1	13			-	1	2	-	1?	11	2		
Femur	UM	1	6			2	-	-	-	-	2	2	2 juvenile	
"	UE	1	5			-	-	1	-	-	2	1		
"	F	1	-			-	-	-	-	-	10	-	1	1 *Mustela*
Tibia	UM	-	6			1	-	-	-	-	1	-		
"	UE	1	2			-	-	-	-	-	1	-		
"	F	2	6			1	-	-	-	-	8	2		
Calcaneum	U	2	5	(3)	(-)	3	-	-	-	-	2	2		
"	F	-	2	(1)	(-)	-	-	-	-	-	8	-		
"	?	2	3	(1)	(-)	-	-	-	-	-	-	-		
Astragalus		2	7	(6)	(-)	2	-	1	-	-	4	1		
Metatarsal	UM	1	6	(1)	(-)	½	-	-	-	-	-	-		
"	UE	-	-			-	-	-	-	-	-	-		
"	F	3	5½	(5½)	(-)	-	-	2	-	-	-	-	2 TmT	
Phalanx I	UM	-	25			-	-	-	-	-	-	-		
"	UE	-	10			-	-	-	-	-	-	-		
"	F	6	28			1	6	1	-	-	4	-		3 BUB
Phalanx III		1	36	(27)	(1)	1	-	-	-	-	-	-		
Metapodial	UM	-	-			1	-	-	-	-	3	-		
"	UE	-	1	(1)	(-)	1	-	-	-	-	-	-		
"	F	1	8½			-	-	-	-	-	12	4		
N		73½	332	(66½)	(4)	45	10	10	1	1?	116	22		

Table 1 – Numbers of teeth and bones of medium and large animals recorded from all stratigraphic units at São Miguel Odrinhas. These are the PoSACs described in Davis (1992; 2002). Single metapodial condyles (*Sus* metapodials and broken bovid metapodials) are counted as halves. For example there were 3 unfused *Sus* metapodial metaphyses; hence the number given is 1½. Taxa are abbreviated as follows: '*Bos*' - cattle (*B. taurus*); 'O' - caprine bones that could not be identified to species as well as those that could be identified as either sheep (*Ovis*) or goat (*Capra*). Thus of the 36 caprine terminal phalanges, one was goat, 27 sheep and eight unidentified sheep or goat. Other taxa are '*Sus*' - pig; 'CEE' – red deer (*Cervus elaphus*); 'CAC' – roe deer (*Capreolus capreolus*); '*Equus*' - equid; 'ORC' – rabbit (*Oryctolagus cuniculus*); *Canis* – dog, and '*Felis*' – cat (*Felis silvestris*). The bone fusion symbols are: 'F' – epiphysis fused (adult), 'UE' and 'UM' - unfused epiphysis and metaphysis respectively (juvenile). 'U' refers to scapulae with unfused coracoid or calcaneum with unfused *tuber calcis*. Among the 'OTHER' taxa recorded here are: 'HIH' – stilt (*Himantopus*); BUB – Eagle owl (*Bubo bubo*); *Pica* – Magpie; ST – starling (*Sturnus*) and TUR – *Turdidae*. CmC and TmT refer to carpometacarpus and tarsometatarsus respectively.

UE	*Bos* N - T - B	*Ovis/Capra* N - T - B	*(Capra)*	*(Ovis)*	*Sus* N - T - B	*Equus* N - T - B	*Cervus* N - T - B	*Capreolus* N - T - B	*Canis* N - T - B	*Felis* N - T - B	*Mustela* N - T - B	*Oryctolagus* N - T - B	*Gallus* N - B	Others	N
29	**3** - 1 - 1	**1** - 1 - 0	-	-	**1** - 0 - 1	**1** - 0 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**6**
33	**27** - 2 - 2	**46** - 6 - 1	-	(2)	**5** - 1 - 1	**0** - 0 - 0	**2** - 0 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**1** - 1		**81**
34	**2** - 1 - 1	**4** - 1 - 1	-	-	**0** - 0 - 0	**0** - 0 - 0	**8** - 1 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**14**
35	**1** - 0 - 1	**0** - 0 - 0	-	-	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**1**
36	**8** - 2 - 1	**20** - 3 - 1	(2)	(1)	**7** - 1 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**35**
37	**1** - 0 - 1	**0** - 0 - 0	-	-	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**1**
38	**0** - 0 - 0	**2** - 0 - 1	(1)	(1)	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**1?** - 0 - 1	**0** - 0 - 0	**1** - 1		**4**
39	**3** - 0 - 1	**8** - 1 - 1	-	-	**5** - 1 - 0	**2** - 0 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**1** - 0 - 1	**1** - 1		**20**
40	**3** - 0 - 1	**6** - 1 - 1	-	(1)	**2**- 1 - 1	**0** - 0 - 0	**1** - 0 - 1	**1?** - 0 - 1?	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**13**
43	**7** - 1 - 1	**90** - 4 - 3	(1)	(25)	**4** - 1 - 0	**4** - 0 - 1	**0** - 0 - 0	**0** - 0 - 0	**186** - 6 - 7	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**291**
49	**1** - 0 - 1	**2** - 0 - 1	-	(1)	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**3**
50	**2** - 1 - 0	**20** - 2 - 1	-	(4)	**8** - 1 - 0	**1** - 0 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**31**
51	**2** - 1 - 0	**5** - 0 - 1	-	(3)	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**7**
52	**17** - 2 - 2	**60** - 1 - 3	-	(21)	**15** - 1 - 1	**2** - 1 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**29** - 0 - 1	**0** - 0 - 0	**0** - 0 - 0	**2** - 1	HIH **1**; BUB **1**	**127**
53	**1** - 0 - 1	**77** - 2 - 3	-	(23)	**2** - 0 - 1	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**2** - 1 - 1	**0** - 0 - 0	**0** - 0 - 0	**5** - 1	ANA **1**; BUB **2**	**90**
54	**0** - 0 - 0	**2** - 0 - 1	-	(1)	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0 - 0	**0** - 0		**2**
Total	**78**	**343**	(83)	(4)	**49**	**10**	**11**	**1?**	**186**	**31**	**1?**	**1**	**10**	**5**	**726**

Table 2 – São Miguel Odrinhas. The total numbers of **bones + teeth** of the medium-sized and large animals (these counts are shown **emboldened**) alongside the estimated minimum number of whole animals represented via teeth (T) and bones (B). UE = stratigraphic number. Shaded UEs (39-54) are from the well filling, unshaded ones (29-38) are from the area above and surrounding the well. Each column includes three numbers – N - T - B. **N** is the total count of bones and teeth; T is the *Minimum Number of Individuals* estimated from the *teeth* only, and B is the Minimum Number of Individuals estimated from the bones only. Where there is a discrepancy between T and B, as for the sheep and goats in UE 33 where the MNI for teeth is 6 and MNI for bones is only 1, we can assume there was a preponderance of heads without their bodies. In all other UEs and for all taxa there is no marked discrepancy between teeth and bone counts and presumably whole bodies or randomly selected parts of bodies were deposited in the well. ANA = *Anas*, goose, BUB = *Bubo*, eagle owl and HIH = *Himantopus*, stilt. Note all the dogs are in UE 43. The cats are mostly in UE 52, with the likely possibility that some of their remains trickled down into UE 53. The counts for *Canis* and *Felis* are slightly inflated as their metapodial and phalanges counts were not adjusted to account for anatomical multiplicity.

UE	Century	Med-large mammals	Microfauna - mandibles	Microfauna - humeri	Totals	% Microfauna
29	IVth / early Vth	6	0	0	6	0
33	IVth / early Vth	81	0	0	81	0
34	1st half Vth	14	0	0	14	0
35	Mid IVth/early Vth	1	0	0	1	0
36	Mid IVth/early Vth	35	1	0	36	3
37	Mid IVth/early Vth	1	0	0	1	0
38	Mid IVth/early Vth	4	0	0	4	0
39	End IVth+early Vth	20	1	1	22	9
40	IVth / early Vth	13	0	0	13	0
43	IVth / early Vth	291	3	0	294	1
49	IVth / early Vth	3	0	0	3	0
50	IVth / early Vth	31	0	0	31	0
51	IVth / early Vth	7	0	2	9	22
52	IVth / early Vth	127	4	18	149	15
53	IVth / early Vth	90	60	64	214	58
54	IVth / early Vth	2	9	5	16	88

Table 3 – Counts of medium-large animal bones and teeth alongside the counts of microfaunal remains (mandibles and humeri of small mammals and reptiles) with the ratio of microfauna to medium-large mammal remains expressed as a percentage. This ratio indicates the relative scarcity of microfauna in the upper levels and increasing density at the bottom of the well. Shaded UEs (39-54) are from the well filling, unshaded ones (29-38) are from the area above and surrounding the well.

Bone	Taxon	Fus	GL	Bd	Dd	BT	HTC	WCM	DEM	WCL	DEL	SD	Box	UE	Notes	ID
Humerus	*Bos*	?					335						VIII	39	BT = 77-79 mm	212
Humerus	*Bos*	F					288						XIII	36	Broken	352
Humerus	*Bos*	F				774	334						XII	53		410
Humerus	*Capra*	F					156						VIII	38	BT = c. 34-35 mm; probable male	184
Humerus	*Capra*	F				283	129						VIII	36	Definite goat	228
Humerus	*Ovis*	F				242	120						VII	43		8
Humerus	*Ovis*	Fv				257	129						XII	52	Proximal epiphysis unfused	480
Humerus	*Ovis?*	F				237	120						VII	43		39
Humerus	*Ovis?*	Fv				257	129						XII	52	Proximal epiphysis unfused	394
Humerus	*Equus*	F	2650			706	363						X	52	GL here = GLC	301
Humerus	*Canis*	F					106						VII	43		168
Humerus	*Canis*	F	710	201			84						VII	43	The small dog Bd = approx	80
Humerus	*Canis*	F		209			82						VII	43		116
Humerus	*Canis*	F		266			109						VII	43		172
Humerus	*Canis*	F		295			112						XIII	43	377 & 388 from same animal?	377
Humerus	*Canis*	F		291			113						XIII	43	377 & 388 from same animal?	378
Humerus	*Canis*	F	1223	229			98					87	IX	43	Proximal epiphysis = Fv	241
Humerus	*Canis*	F	1404	293			118					103	IX	43	Proximal epiphysis = F	261
Humerus	*Canis*	F	1462	271			107					110	IX	43	Prox. epiphysis = F; 243 & 242 from same animal?	242
Humerus	*Canis*	F	1460	273			107					110	IX	43	Prox. epiphysis = F; 243 & 242 from same animal?	243
Humerus	*Canis*	UE		317			123						VII	43	Bd = approx	115
Humerus	*Canis*	F		316			116						IX	43		240
Humerus	*Felis*	F		178			59						XII	52	Entire skeleton	571
Humerus	*Felis*	F		179			59						XII	52	Entire skeleton	572
Humerus	*Galliform*	juv		147								65	XII	53		415
Radius	*Bos*	Fv	2484									364	XII	52		395
Metacarpal	*Bos*	F								305	240		IX	43	Uncertain whether condyle medial or lateral	285
Metacarpal	*Bos*	F		640	330			299	239	313	259		VIII	40	Bd & Dd = approx	200
Metacarpal	*Bos*	F		654				319	252	310	239		VIII	40	Bd, WCL & DEL = approx	201
Metacarpal	*Bos*	F	1797	489	255			242	195	227	186	284	XII	52		396
Metacarpal	*Bos*	F	1954	660				318	269	306	249		VIII	33	Fragmented - glued together	
Metacarpal	*Ovis*	F		216	142			102	94	101	89		VIII	38		185
Metacarpal	*Ovis*	F		219	156			109	104	103	94		VIII	40		199
Metacarpal	*Ovis*	F		227	141			105	89	108	95		XII	54		413
Metacarpal	*Ovis*	F	1056	239				115	93		94	122	XII	53	426 & 417 from same animal	426
Metacarpal	*Ovis*	F	1064	239	147			116	95	114	85		XII	53	426 & 417 from same animal	417
Metacarpal	*Ovis*	F	1082	224	141			107	94	103	88		XII	53	Broken in two in antiquity each with different colour	418
Metacarpal	*Ovis*	Fv	1070	218	142			107	96	102	89	122	VII	43	11 & 12 from same animal?	11
Metacarpal	*Ovis*	Fv	1064	216	141			103	94	100	88	119	VII	43	11 & 12 from same animal?	12
Metacarpal	*Equus caballus*	F	2196	483	351							315	XIII	43	Identified via curvature of shaft sides	383
Femur	*Canis*	F	1597									109	IX	43		246
Femur	*Canis*	F	1611									106	IX	43	247 & 248 from same animal?	247
Femur	*Canis*	F	1609									110	IX	43	247 & 248 from same animal?	248
Femur	*Mustela cf erminea*	F	346	68									VIII	38		183
Femur	*Galliform*			157									VIII	33	Bd = approx; probably *Gallus*	229
Tibia	*Bos*	F		509									XIII	39		373
Tibia	*Bos*	F		620									X	52	Very robust	293
Tibia	*Sus*	F		285									XIII	33		364
Tibia	*Canis*	F		144									VII	43		110
Tibia	*Canis*	F		181									IX	43	Distal part only; break = fresh	250
Tibia	*Canis*	F		204									XIII	43		376
Tibia	*Canis*	F	1624	201									IX	43	Proximal epiphysis fused	245
Calcaneum	*Ovis*	F	529										XIII	33		363
Calcaneum	*Canis*	F	278										VII	43		106
Calcaneum	*Canis*	F	342										VII	43		142
Calcaneum	*Canis*	F	376										IX	43		239
Calcaneum	*Canis*	F	378										IX	43		260
Calcaneum	*Canis*	F	410										IX	43		267
Calcaneum	*Canis*	F	415										IX	43		259
Calcaneum	*Canis*	F	422										VIII	43		207
Astragalus	*Bos*		613	402	344								VIII	33	Dl = approx.	224
Astragalus	*Bos*		614	381									VIII	33	Broken	181
Astragalus	*Ovis*		246	165	138								XI	49	Definite sheep; very small	327
Astragalus	*Ovis?*		264	168	142								XII	52	Shape = goat; same animal as 660	555
Astragalus	*Ovis?*		264	168	141								XII	52	Shape = goat; same animal as 555	660
Astragalus	*Ovis*		281	170	153								XI	50	Definite sheep	318
Astragalus	*Ovis?*		240	157									VIII	33	Bd = approx; very abraded	191
Astragalus	*Equus*			354									VIII	29	GH = 408; LmT = 419; GB = c.450	188
Astragalus	*Canis*		225										IX	43		251
Astragalus	*Canis*		226										VII	43		140
Astragalus	*Canis*		228										VII	43		143
Astragalus	*Canis*		268										VII	43		82
Astragalus	*Felis*		161										XII	52	Entire skeleton	554
Metatarsal	*Bos*	F		561	316			270	228	252	217		XIII	33		357
Metatarsal	*Bos*	F		628	361			300	267	285	251		XIII	34		360
Metatarsal	*Bos*	F	2271	595	339			278	245	272	234		XIII	35	GL = approx.	336
Metatarsal	*Ovis*	F		211	139								XII	53	Two halves broken in antiquity	397
Metatarsal	*Ovis*	F		209	141								XII	53		425
Metatarsal	*Ovis*	F	1124	226	146							103	X	53		288
Metatarsal	*Ovis*	Fv	1170	206	144							105	VII	43	Same skeleton as 14?	13
Metatarsal	*Ovis*	Fv	1171	208	144							104	VII	43	Same skeleton as 13?	14
Metatarsal	*Equus*	F	2805	498	368							326	XI	50	Very large; Dd = approx	335
Metatarsal	*Equus cf caballus*	F	2870	474	364							305	XIII	39		374
Phalanx prox.	*Equus cf caballus*	F	816	415	230							320	XIII	39	Bp = 522; Prox depth = 366	351
Tarso-Mt	*Gallus?*			125								57	VIII	38	*Gallus cf gallus*	186

Appedix A – The Roman well filling from São Miguel Odrinhas. Measurements, in tenths of a millimetre, of bones of the medium and large mammals and birds arranged by part of skeleton and taxon. Measurement abbreviations follow Driesch (1976) and Davis (1996). For the astragalus GL = GLl and Dd = Dl. Box refers to the location of the bone, UE is the stratigraphic find number and ID is the unique data-base identifier of the bone.

Complement	Taxon	dP_4length	dP_4W	M_1length	M_1Wa	M_1Wb	M_2length	M_2Wa	M_2Wb	M_3length	M_3Wa	M_3Wb	Box	UE	Notes	ID
M_3	*Bos*											147	VIII	33	Broken, hypoconulid present	47
M_2-M_3	*Bos*										150		VIII	36	Length M_3 = c. 30-32 mm hypoconulid broken but existed	21
M_3	*Bos*										145		IX	43	Length = c. 35 - 36 mm; hypoconulid present	71
M_3	*Bos*										157	140	VIII	36	Hypoconulid missing	31
M_2-M_3	*Bos*										158	142	XI	50	Hypocunlid present	85
M_3	*Bos*									324	153	148	X	51	Hypoconulid present	81
P_4-M_3	*Bos*									342	144	141	XII	52	M_3 - hypoconulid present	218
M_3	*Bos*									392	165	153	XIII	33	Hypoconulid present	115
M_3	*Bos*									396	166		XIII	34	Hypoconulid present	102
P_3-M_2	*Canis*			156	58								VII	43	Young adult; 12 & 13 probably from same animal	12
P_1-M_2	*Canis*			158	58								VII	43	Young adult; 12 & 13 probably from same animal	13
M_1	*Canis*			171	69								VII	43	Reduced metaconid	10
Mandible	*Canis*			176	68								IX	43		77
Mandible	*Canis*			191	76								IX	43	74 & 75 same dog P_4 lost antemortem	74
Mandible	*Canis*			192	73								IX	43	74 & 75 same dog P_4 lost antemortem	75
P_4-M_2	*Canis*			199	75								VII	43	Some wear on enamel only 18 & 19 same animal	18
P_4-M_2	*Canis*			200	76								VII	43	Some wear on enamel only 18 & 19 same animal	19
Mandible	*Canis*			199	78								IX	43	Dentine slightly exposed	76
P_1-M_1	*Canis*			209	82								VIII	43	Very slight wear on enamel only	68
M_1	*Canis*			213	82								VII	43	Young adult	11
M_1	*Canis*			220	82								VII	43	Some wear on enamel only	17
Mandible	*Felis*			82	35								XII	53	Skull length P_3-M_1 = 211	158
M_1-M_2	*Sus*					89		98					XIII	39		101
C,P_2-M_3	*Sus*			143	97	100	190	120	124	283	136	124	XI	50	M_3 tri-angular in occlusal view; female	82
P_3-M_3	*Sus*			146	97	101	171	110		260	130	131	VII	43	lengths M_1 & M_2 short - inter-dental abrasion	14
M_1-M_3	*Sus*			158	91	98	190	113	116				XIII	39		95
dP_3-M_1	*Sus*	190	83										XII	52		214
dP_4	*Sus*	191	87										VIII	33		39

Appendix A – Teeth measurements.
The Roman well filling from São Miguel Odrinhas. Measurements, in tenths of a millimetre, of teeth of the medium and large mammals. The crown width of M_3 is measured at its widest point, near the base, and as illustrated in figure 11 of Davis (2008). Box refers to where the bone is located, UE is the stratigraphic find number and ID is the unique data-base identifier of the bone.

	0	1	2	3	4	4/5	5	6	7	8	9	10	10/11	11	12	13	14	15	16	17	18	19	20	21	22	23	P	Total
dP_4: (CAH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0)
(OVA	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2	–	–	4	–	–	–	–	–	–	–	–	8)
O/C	–	–	–	–	–	–	–	–	–	2	–	1	–	–	–	2	–	–	4	–	–	–	–	–	–	–	1	10
O/C P_4:	1	–	–	–	1	–	–	–	–	1	5	–	–	–	2	–	1	–	–	–	–	–	–	–	–	–	–	11
O/C M_1:	2	2	–	–	–	–	–	–	2	–	6	1	–	1	1	–	–	2	–	–	–	–	–	–	–	–	–	17
O/C $M_{1/2}$:	–	–	–	–	–	–	2	2	8	1	16	–	–	2	1	–	1	2	–	–	–	–	–	–	–	–	1	36
O/C M_2:	–	–	2	–	–	–	–	–	4	–	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14
O/C M_3:	4	1	–	1	–	1	2	–	–	1	3	1	1	7	–	–	–	–	–	–	–	–	–	–	–	–	1	22
	0	1	2	3	4	4/5	5	6	7	8	9	10	10/11	11	12	13	14	15	16	17	18	19	20	21	22	23	P	Total

Appendix B – Tooth eruption and wear stages.
São Miguel de Odrinhas; wear stages of the **sheep/goat** (O/C; *Ovis/Capra*) mandibular teeth (following Payne, 1987). These wear stages extend from teeth just erupted with unworn enamel (*i.e.*, no dentine exposed) in stage "0" to teeth from very old animals with hardly any crown left. "P" includes teeth that could not be assigned to a wear stage. Many of the deciduous fourth premolars could be identified to species. These are shown in parentheses, "CAH" (*Capra hircus*) goat and "OVA" (*Ovis aries*) sheep. "O/C" includes these and the unidentified caprine dP_4s.

	a	b	b/c	c	d	e	f	g	h	i	j	k	l	m	n	o	p	P	Total
Pig dP_4:	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–			–	3
Pig P_4:	–	1	–	1	1	1	–	–	–	–	–	–	–	–	–			–	4
Pig M_1:	1	–	1	1	–	–	2	1	–	–	1	–	–	–	–			–	7
Pig $M_{1/2}$:	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			–	0
Pig M_2:	2	–	–	–	1	1	–	1	–	–	–	–	–	–	–			–	5
Pig M_3:	3	–	–	–	–	–	–	1	–	–	–	–	–	–	–			–	4

	a	b	c	d	e	f	f/g	g	h	i	j	k	l	m	n	o	p	P	
Cattle dP_4:	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	2
Cattle P_4:	–	–	1	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	3
Cattle M_1:	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	2
Cattle $M_{1/2}$:	–	–	–	1	–	–	1	2	–	–	–	1	2	2	–	–	–	2	11
Cattle M_2:	–	–	–	–	–	–	–	2	–	–	–	1	–	–	–	1	–	–	4
Cattle M_3:	–	1	–	–	–	1	–	3	–	–	–	2	1	1	–	–	–	2	11

São Miguel de Odrinhas; wear stages of the **pig** and **cattle** mandibular teeth (following Grant, 1982). These wear stages extend from teeth just erupted with unworn enamel (*i.e.*, no dentine exposed) in stage "a" to teeth from very old animals with hardly any crown left. "P" includes teeth that could not be assigned to a wear stage.

References

ALBARELLA, Umberto; DAVIS, Simon J.M.; DETRY, Cleia; ROWLEY-CONWY; Peter (2005) – Pigs of the "Far West": the biometry of *Sus* from archaeological sites in Portugal. *Anthropozoologica*. 40, pp. 27–54.

ARGANT, Thierry; THOMAS, Richard; MORRIS, James (2013) – Absent/reduced hypoconulids in mandibular third molars amongst domestic cattle in north-west Europe: a preliminary investigation and some speculations. In *5th international conference of the ICAZ Animal Palaeopathology Working Group Osteoarchaeological Research Laboratory, University of Stockholm, Sweden*.

ARMITAGE, Philip L.; WEST, Barbara; STEADMAN, Ken (1984) – New evidence of Black rat in Roman London. *The London Archaeologist*. 4, pp. 37583.

BAXTER, Ian L. (2010) – Small Roman dogs. *Alexandria Archive*. 901, pp. 1–9. < http://alexandriaarchive.org/bonecommons/items/show/901 >.

BENECKE, Norbert (1993) – On the utilization of the domestic fowl in central Europe from the Iron Age up to the Middle Ages. *Archaeofauna*. 2, pp. 21–31.

BENNETT, Deb; CAMPBELL, Greg; TIMM, Robert M. (2016) – The dogs of Roman Vindolanda, Part I: Morphometric techniques useful in differentiating domestic and wild canids. *Archaeofauna*. 25, pp. 79–106.

BENNETT, Deb; TIMM, Robert M. (2016) – The dogs of Roman Vindolanda, Part II: Time-stratigraphic occurrence, ethnographic comparisons, and biotype reconstruction. *Archaeofauna*. 25, pp. 107–126.

BERKE, Hubert (2003) – Die Tierknochen aus den Ausgrabungen der römischen Flotte an der Altenburg in Köln im Jahre 1998. *Kölner Jahrbuch*. 36, pp. 713–725.

BLANK, T. H. (1984) – Pheasants and partridges. In MASON, Ian Lauder, ed. – *Evolution of domesticated animals*. London; New York, NY: Longman, pp. 311–315.

BOESSNECK, Joachim (1969) – Osteological differences between sheep (*Ovis aries* Linné) and goat (*Capra hircus* Linné). In: Brothwell, D. and Higgs, E.S., eds. – *Science in archaeology* 2nd ed. London: Thames and Hudson, pp. 331358.

BOESSNECK, Joachim (1976) – Tell el-Dab'a III. Die Tierknochen-funde 1966-1969. *Osterreichischen Akademie der Wissenschaften Denkschriften der Gesamtakademie*. 5, pp. 7–42.

BOESSNECK, Joachim; MÜLLER, Hanns-Hermann; TEICHERT, Manfred (1964) – Osteologische Unterscheidungsmerkmale zwischen Schaf (*Ovis aries* Linné) und Ziege (*Capra hircus* Linné). *Kühn-Archiv*. 78, pp. 1–129.

BONIFAY, Michel (2004) – *Etudes sur la céramique romaine tardive d'Afrique*. Oxford: Archaeopress.

BROGUIOLO, Gian Pietro; CHAVARRÍA, Alexandra (2008) – El final de las *Villas* y las transformaciones del territorio rural en el Occidente (siglos V–VIII). In *Las* villae *tardorromanas en el occidente del Imperio: arquitectura y función. Actas del IV Coloquio Internacional de Arqueología de Gijón*. Gijón: Ediciones Trea, pp. 193–214.

COELHO, Catarina (2007) – Ruinas arqueológicas de São Miguel de Odrinhas: a propósito da campanha de 1997. *Arqueologia e História*. 58–59, pp. 119–142.

DAVIS, Simon J. M. (1992) – *A rapid method for recording information about mammal bones from archaeological sites*. London, HBMC AM Laboratory report 19/92.

DAVIS, Simon J. M. (1996) – Measurements of a group of adult female Shetland sheep skeletons from a single flock: a baseline for zooarchaeologists. *Journal of Archaeological Science*. 23, pp. 593–612.

DAVIS, Simon J. M. (2002) – The mammals and birds from the Gruta do Caldeirão, Portugal. *Revista Portuguesa de Arqueologia*. 5, pp. 29–98.

DAVIS, Simon J. M. (2007) – *The mammals and birds from the Iron Age and Roman periods of Castro Marim, Algarve, Portugal* (Trabalhos do CIPA 107) Lisboa: Instituto Português de Arqueologia.

DAVIS, Simon J. M. (2008) – Zooarchaeological evidence for Moslem and Christian improvements of sheep and cattle in Portugal. *Journal of Archaeological Science*. 35:4, pp. 991–1010.

DAVIS, Simon J. M. (in press) – A metrical distinction between sheep and goat astragali. In ROWLEY-CONWY, Peter; SERJEANTSON, Dale; HALSTEAD, Paul, eds. – *Economic zooarchaeology: studies in hunting, herding and early agriculture*. Oxford: Oxbow.

DAVIS, Simon J. M.; GONÇALVES, Maria João; GABRIEL, Sónia (2008) – Animal remains from a Moslem period (12th/13th century AD) *lixeira* (garbage dump) in Silves, Algarve, Portugal. *Revista Portuguesa de Arqueologia*. 11:1, pp. 183–258.

DAVIS, Simon J. M.; SVENSSON, Emma M.; ALBARELLA, Umberto; DETRY, Cleia; GÖTHERSTRÖM, Anders; PIRES, Ana E.; GINJA, Catarina (2012) – Molecular and osteometric sexing of cattle metacarpals: a case study from 15th century AD Beja, Portugal. *Journal of Archaeological Science*. 39:5, pp. 1445–1454.

DRIESCH, Angela von den (1976) – *A guide to the measurement of animal bones from archaeological sites*. Cambridge, MA: Harvard University.

DRIESCH, Angela von den; BOESSNECK, Joachim (1976) – Die Fauna vom Castro do Zambujal (Fundmaterial der Grabungen von 1966 bis 1973 mit Ausnahme der Zwingerfunde). pp. 4-129. In: DRIESCH, A. von den; Boessneck, Joachim, eds. – *Studien über frühe Tierknochenfunde von der Iberischen Halbinsel 5*. Institut für Palaeoanatomie, Domestikationsforschung und Geschichte der Tiermedizin der Universität München. Deutsches Archäologisches Institut Abteilung Madrid. München.

EISENMANN, Véra (1981) – Etude des dents jugales inferieures des *Equus* (Mammalia, Perissodactyla) actuels et fossiles. *Palaeovertebrata*. 10, pp. 127–226.

GONÇALVES, Alexandre (2014) – The faunal assemblage from a Roman well in the villa of São Miguel de Odrinhas (Sintra, Portugal): a preliminary view on the archaeological context. In DETRY, Cleia; DIAS, Rita, eds. – *The First Zooarchaeology Conference in Portugal*. Oxford: Archaeopress, pp. 77–85.

GRANT, Annie (1982) – The use of tooth wear as a guide to the age of domestic ungulates. In WILSON, Bob; GRIGSON, Caroline; PAYNE, Sebastian, eds. – *Ageing and sexing animal bones from archaeological sites*. Oxford: British Archaeological Reports, pp 91–108.

HARCOURT, Ralph A. (1974) – The dog in prehistoric and early historic Britain. *Journal of Archaeological Science*. 1, pp. 151–175.

HAYES, John (1972) – *Late Roman pottery*. London: The British School at Rome.

HERNÁNDEZ CARRASQUILLA, Francisco (1992) – Some comments on the introduction of domestic fowl in Iberia. Madrid. *Archaeofauna*. 1, pp. 45–53.

HOOPER, William Davis (1935) – *Marcus Porcius Cato on agriculture, Marcus Terentius Varro on agriculture*. London: William Heinemann.

KÜCHELMANN, Hans Christian (2013) – Tierknochen aus der Siedlung der Vorrömischen Eisenzeit und Römischen Kaiserzeit Bentumersiel bei Jemgum, Landkreis Leer (Ostfriesland). *Siedlungs - und Küstenforschung im südlichen Nordseegebiet*. 36, pp. 63–85.

MACDONALD, Kevin C. (1992) – The domestic chicken (*Gallus gallus*) in sub-Saharan Africa: a background to its introduction and its osteological differentiation from indigenous fowls (Numidinae and *Francolinus* sp.). *Journal of Archaeological Science*. 19, pp. 303–318.

MACKINNON, Michael (2010) – 'Sick as a dog': zooarchaeological evidence for pet dog health and welfare in the Roman world. *World Archaeology*. 42:2, pp. 290–309.

MACKINNON, Michael; BELANGER, Kyle (2006) – In sickness and in health: care for an arthritic Maltese dog from the Roman cemetery of Yasmina, Carthage, Tunisia. In SNYDER, Lynn M.; MOORE, Elisabeth A. eds. – *Dogs and people in social, working, economic or symbolic interaction*. Oxford: Oxbow, pp. 38–43.

MONGIN, P.; PLOUZEAU, M. (1984) – Guinea-fowl. In MASON, Ian Lauder, ed. – *Evolution of domesticated animals*. London; New York, NY: Longman, pp. 322–325.

O'CONNOR, Terence P. (2000) – *The archaeology of animal bones*. Stroud: Sutton Publishing.

PAYNE, Sebastian (1969) – A metrical distinction between sheep and goat metacarpals. In UCKO, Peter J.; DIMBLEBY, Geoffrey W., eds. – *The domestication and exploitation of plants and animals*. London: Duckworth, pp. 295–305.

PAYNE, Sebastian (1973) – Killoff patterns in sheep and goats: the mandibles from Aşvan Kale. *Anatolian Studies*. 23, 281–303.

PAYNE, Sebastian (1987) – Reference codes for wear states in the mandibular cheek teeth of sheep and goats. *Journal of Archaeological Science*. 14, pp. 609–614.

PAYNE, Sebastian; BULL, Gail (1988) – Components of variation in measurements of pig bones and teeth, and the use of measurements to distinguish wild from domestic pig remains. *Archaeozoologia*. 2, pp. 27–65.

RACKHAM, James D. (1979) – *Rattus rattus*: the introduction of the black rat into Britain. *Antiquity*. 53, pp. 112–120.

SMITH, Richard N. (1969) – Fusion of ossification centres in the cat. *Journal of Small Animal Practice*. 10:9, pp. 523–530.

TOMEK, Teresa; BOCHEŃSKI, Zbigniew M. (2009) – *A key for the identification of domestic bird bones in Europe: Galliformes and Columbiformes*. Kraków: Institute of Systematics and Evolution of Animals, Polish Academy of Sciences.

ZEUNER, Frederick E. (1963) – *A history of domesticated animals*. London: Hutchinson.